

Air Force Research Laboratory



AIR FORCE SHIFT WORKER FATIGUE SURVEY

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SUMMARY

An Internet-based survey was conducted during the fall and winter of 2003-2004 to help assess the impact of shift worker fatigue on ground mishaps and operational errors. The survey was designed for those commanders, first sergeants, superintendents, supervisors, schedulers, and shift workers in 24/7 operations. In addition, aerospace physiologists, flight surgeons, chiefs of medical staff, and wing ground safety personnel were asked to participate. Of the 9,242 respondent 5,890 were shiftworkers and 1,866 were shift supervisors and schedulers. The survey results represented primarily opinions from ACC, PACAF, USAFE and AETC, and not AMC; from workers and supervisors in grades E1 through E6; and from shift workers, shift supervisors and shift schedulers. The survey results prompted these main recommendations:

- Fatigue management and sleep hygiene training should be made mandatory for shiftworkers and their schedulers, managers and supervisors. The training should be implemented through the Human Performance Training Teams of SG.
- The large mismatch between supervisor and shift worker reports of frequency of off-duty employment should be investigated.
- Shift work scheduling and worker rest policies for non-flyers should be created.
- Operational risk management (ORM) for fatigue should be implemented for workers on the mid shift (midnight to dawn).
- The rest days in a shift work schedule should be treated in the same manner as the formal, inviolable crew-rest periods for aircrews.
- The reason for low compliance in reporting fatigue-related incidents that occur at work should be determined.
- Air Force manpower and personnel planners should be trained to allocate the proper numbers of workers to 24/7 operations.
- The number of shift lengths greater than 13 hours should be reduced sharply. Weekly and annual rotations and fixed shifts should be eliminated. Shift work schedules should reflect strong predictability and equity.
- Management should reduce sharply the need for shift workers to come in on days off.
- An automated shift work scheduling tool is needed.
- Possible relationships among reported shift worker depression, reported excessive drinking by shift workers and the recent upswing in suicide frequency in the Air Force should be investigated.

PREFACE

This report covers the project period of 1 Oct 2004 to 31 Mar 2005. The work was performed under AFRL Job Order Number 7757P905.

The project manager was Dr. James C. Miller, Fatigue Countermeasures Branch (AFRL/HEPF), Biosciences and Protection Division, Air Force Research Laboratory, Brooks City-Base TX. The project included data reduction, analysis and interpretation of survey data. The survey was designed and conducted by Capt Robert A. Sides.

AIR FORCE SHIFT WORKER FATIGUE SURVEY

INTRODUCTION

An Internet-based survey was conducted during the fall and winter of 2003-2004 to help assess the impact of shift worker fatigue on ground mishaps and operational errors. The survey was designed for those commanders, first sergeants, superintendents, supervisors, schedulers, and shift workers in 24/7 operations. In addition, aerospace physiologists, flight surgeons, chiefs of medical staff, and wing ground safety personnel were asked to participate. The personnel who participated in this survey remain anonymous.

METHODS

A request was sent to Major Commands who then provided potential respondents with a Universal Resource Locator (URL) link to the Internet survey site. The respondent categories and sample sizes were as follows:

- Shift workers, n = 5,890
- Supervisors/Schedulers, n = 1,866 (Supv/Sched)
- Superintendents and Senior Enlisted, n = 790 (Supt/SE)
- First Sergeants and Commanders, n = 464 (1stSgt/CC)
- Aerospace Physiologists, n = 38 (AP)
- Flight Surgeons, n = 90 (FS)
- Chiefs of Medical Staff, n = 29 (CMS)
- Wing Ground Safety, n = 75 (SEG)
- Total n = 9,242

The instructions for respondents were: "Welcome to the Shift worker Fatigue (SW) Web-Based Questionnaire. This information will support a review. ... Your answers are very important ... and will assist us in providing Air Force senior leaders with a valid assessment of Shift worker Fatigue (SWF) and in making recommendations on how to maximize safety, minimize fatigue, and reduce operational errors."

Three demographic questions were asked of all respondents. Comparative questions were asked in 11 areas. None of the comparative questions addressed all respondent categories. Comparisons were made for:

- Training
- Most common shift worker complaints
- Off-duty employment
- Social or behavioral trends
- Policy guidance
- Shift characteristics
- Sleep characteristics
- Fatigue countermeasure techniques

- Leader attitudes
- Pre-dawn tasks
- Endurance Management Program

The demographic questions are addressed first in the Results and Discussion section, followed by comparative items and then questions unique to each respondent category.

RESULTS AND DISCUSSION

The survey elicited 9,242 usable responses. The responses represented primarily the views from ACC, PACAF, USAFE and AETC, but not AMC. The respondents were primarily shift workers, shift supervisors and shift schedulers in grades E1 through E6.

DEMOGRAPHICS

Which of the following describes your major command or organization? About 32% of the responses came from ACC, 41% from PACAF and USAFE combined, and 19% from AETC (Figure 1). The Reserve components provided 2.4% of the responses. Disappointingly, only 3% of the responses came from AMC.

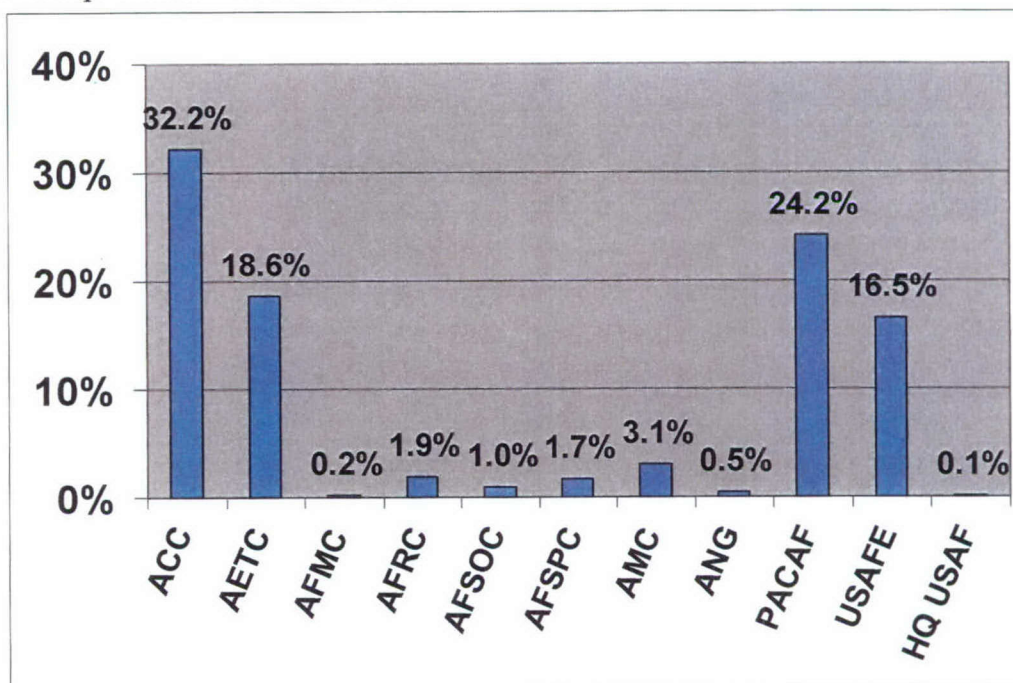


Figure 1. Distribution of respondents across organizations.

What is your rank? Over 75% of the responses came from grades E1 through E6 (Figure 2). About 10% of the respondents were officers.

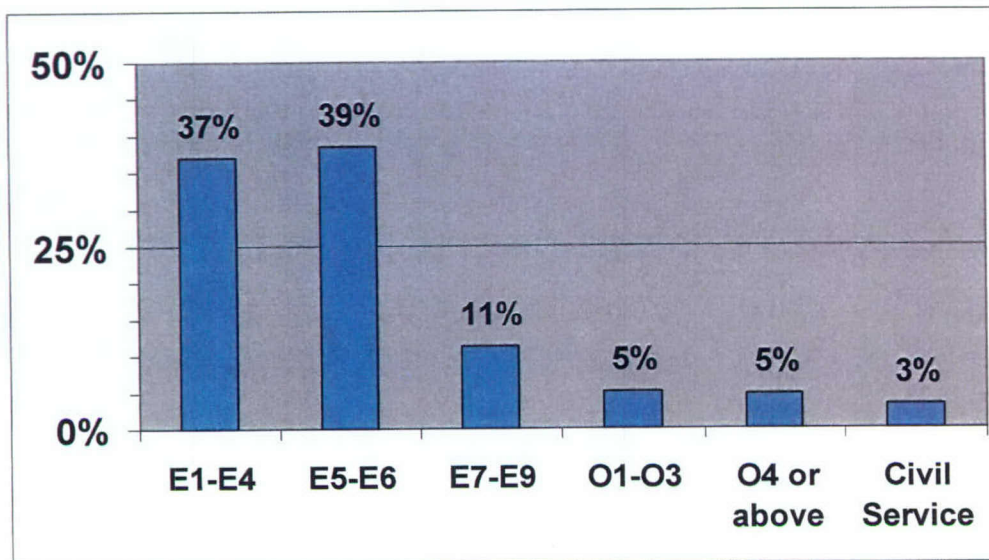


Figure 2. Distribution of respondents by grade.

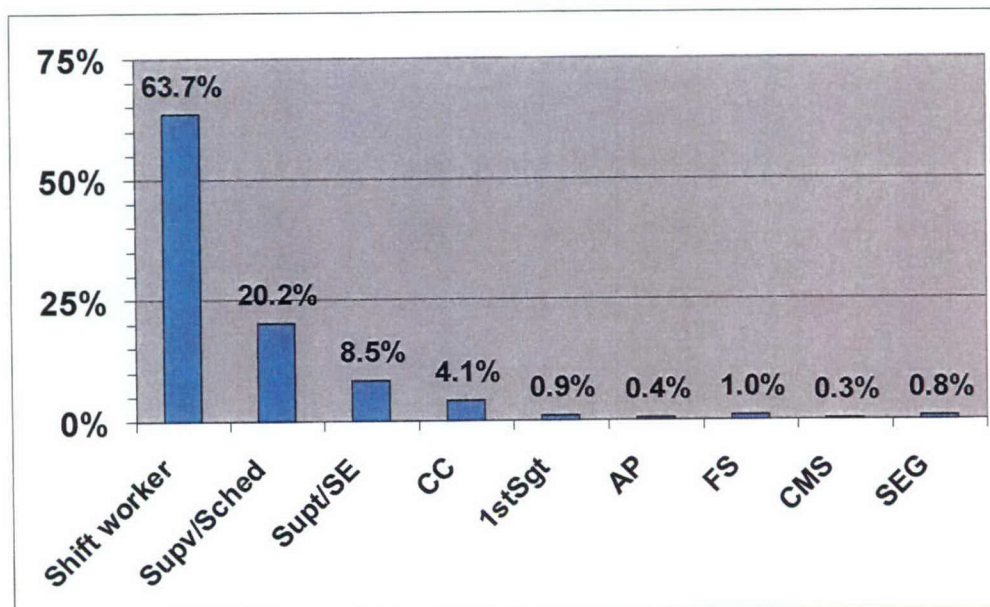


Figure 3. Distribution of respondents by shift work participation. Key: Supervisors and Schedulers (Supv/Sched), Superintendents and Senior Enlisted (Supt/SE), First Sergeants (1stSgt), Commanders (CC), Aerospace Physiologists (AP), Flight Surgeons (FS), Chiefs of Medical Staff (CMS), Wing Ground Safety (SEG).

Which best describes you? Respondents classified themselves as Shift workers, Supervisors and schedulers (Supv/Sched), Superintendents and Senior Enlisted (Supt/SE), First Sergeants (1stSgt), Commanders (CC), Aerospace Physiologists (AP), Flight Surgeons (FS), Chiefs of Medical Staff (CMS), or Wing Ground Safety (SEG). About 84% of the respondents were involved directly in shift work as a shift worker, shift supervisor or shift scheduler (Figure 3).

TRAINING ISSUES

Supv/Sched and CMS were asked, *Have you received any formal, supervisor-level training on how to schedule shifts to maximize duty performance?* Not even half of the Supv/Sched and very few CMS reported receiving shift-scheduling training:

	<u>Supv/Sched</u>	<u>CMS</u>
Yes:	42%	17%
No:	58%	83%

Shift workers and CMS were asked about sleep hygiene training: *Have you had training on sleep hygiene (proper sleep environment, use of sleep aids, relaxation techniques, etc.)?* Very few shift workers and not even half of CMS had received training:

	<u>Shift workers</u>	<u>CMS</u>
Yes:	17%	45%
No:	78%	55%
Don't know	5%	

Shift workers were asked, *Was this training effective in minimizing fatigue?* Of the 16% of the respondents who reported receiving training on sleep hygiene, about half felt that the training was effective. Shift workers were also asked where they received their sleep hygiene training. They reported the following distribution:

Basic or commissioning training:	4%
Local in-service or supervisor:	2%
Medical group personnel:	6%
N/A:	82%
Other:	7%
Professional Military Education (PME):	2%
Safety office:	1%
Unit provided:	2%

Shift workers, Supt/SE, 1stSgt/CC and, SEG were asked about fatigue countermeasures training: *Have you received any fatigue countermeasures training (proper nutrition, proper use of stimulants, proper lighting, etc.)?* The proportion of respondents who answered *Yes* increased with increasing supervisory level:

	<u>Shift workers</u>	<u>Supt/SE</u>	<u>1stSgt/CC</u>	<u>SEG</u>
Yes:	16%	24%	38%	43%
No:	70%	70%	61%	57%
Don't know:	14%	6%	1%	0

They were then asked, *Was this training effective in minimizing fatigue?* They responded:

	<u>Shift workers</u>	<u>Supt/SE</u>	<u>1stSgt/CC</u>	<u>SEG</u>
Yes:	9% (56%)	16% (67%)	25% (66%)	40% (93%)

Fatigue management training was not mandatory for non-flying personnel. Thus, the trainers, mainly aerospace physiologists and flight surgeons, were forced to search for opportunities when they could conduct training. They had varying success gaining access to commanders' calls, the First Term Airman Center and Developmental Education courses.

Generally, only about half of those trained reported that the training was effective. The training may have been somewhat lacking, the methods too tedious and/or shift workers did not taking the training seriously.

Shift workers, Supt/SE, 1stSgt/CC, and SEG were asked where they received their fatigue countermeasures training. They reported the following distributions:

	<u>Shift workers</u>	<u>Supt</u>	<u>1stSgt/CC</u>	<u>SEG</u>
Basic or commissioning training:	4%	3%	6%	3%
Local in-service or supervisor:	2%	7%	2%	4%
Medical group personnel:	7%	11%	22%	16%
N/A:	83%	75%	62%	56%
Other:	5%	5%	15%	16%
PME:	2%	7%	6%	7%
Safety office:	1%	7%	8%	16%
Unit provided:	2%	8%	5%	9%

At the time the survey was conducted, each Wing's Human Performance Training Team (HPTT), where available, was tasked to provide fatigue training to all base units in need of same¹. The Aerospace Physiology members of an HPTT may have been identified by respondents as "other," even though they were medical personnel. At best, the HPTTs had trained only 12% of responding shift workers.

A small proportion of respondents reported receiving sleep hygiene training during basic or commissioning training. Were this true, it implies that 95% of the trainees were not paying attention that day, or that there was ambiguity in the training such that only a small portion of the trainees realized that they were receiving sleep hygiene and fatigue countermeasures training.

Supv/Sched and Supt/SE were asked, *Do you train your shift workers on proper sleep hygiene/fatigue avoidance techniques?*

	<u>Supv/Sched</u>	<u>Supt/SE</u>
Yes:	31%	27%
No:	69%	73%

CMS were asked:

Are your providers trained on proper sleep hygiene / fatigue avoidance techniques?

Yes:	21%
No:	52%
Don't know:	28%

¹ For example, Air Force Instruction 11-403, 20 February 2001, Flying Operations, Aerospace Physiological Training Program, Par 1.1.1.4.

Are your providers trained on the health risks associated with shift work?

Yes: 38%
No: 34%
Don't know: 28%

The low proportions of leaders who reported that they trained their shift workers reflected the low proportions of leaders who were, themselves, trained. Supv/Sched and CMS were asked, *Are you aware of the Air Force resources available to provide this training?*

	<u>Supv/Sched</u>	<u>CMS</u>
Yes:	19%	17%
No:	81%	83%

Available, relevant materials apparently had not been circulated widely enough in the Air Force shift work community. They included the brochures:

- *Plain Language about Shiftwork*, National Institute for Occupational Safety and Health (NIOSH), 1997²
- *Shift Work*, Fatigue Countermeasures Branch, Air Force Research Laboratory (AFRL/HEPF), 1999³
- *Sleep Strategies for Shift Workers*, National Sleep Foundation (NSF), 2001⁴

Many of the available suggestions were summarized by NIOSH:

- "As appropriate, employers might consider changes in shiftwork schedules -- such as considering alternatives to permanent night shifts, avoiding quick shift changes, and adjusting shift length to the workload. Whether a particular change is useful depends on the specific work situation. When changing employees' work schedules, all aspects of the worker's job and home life should be considered, the publication suggests.
- "Other potentially useful steps include scheduling heavy or demanding work at times when workers are most alert or at peak performance, providing training or awareness programs for new shiftworkers and their families, and ensuring that health care and counseling services are available to employees who work non-traditional schedules.
- "Employees may consider various ways for coping with shiftwork, such as increasing their awareness of the need to get good sleep, establishing the sleep routine that works best for the individual, and looking at the utility of exercise, diet, and relaxation techniques for helping resist stress.
- "Bright lights also might be used to adjust the body's circadian rhythm and change the times of an individual's peak alertness, but this strategy takes expert planning and may not be practical for some shift workers. Melatonin has received attention as a sleep aid, but research is insufficient at this time to recommend melatonin as a regular aid for shift workers, the publication also finds."⁵

² NIOSH (DHHS) Publication No. 97-145, available at no charge by calling the toll-free NIOSH information number, 1-800-35-NIOSH (1-800-356-4674). NIOSH Web site: <http://www.cdc.gov/niosh>.

³ Available on line at <http://www.brooks.af.mil/AFRL/HEP/HEPF/Brochures/Shiftwork.pdf>.

⁴ Available on line at <http://www.sleepfoundation.org/publications/shiftworker.cfm>.

⁵ <http://www.cdc.gov/niosh/shift.html>, March 2005.

Shift workers, superintendents, first sergeants and commanders, and CMS were asked, *Where would fatigue countermeasures / sleep hygiene training be most effective?* They responded:

	Shift workers	Supt	1 st Sgt/CC	CMS	SEG
Basic or Commissioning Training:	12%	7%	16%	3%	12%
HAWC:	18%	14%	18%	21%	4%
ORM Training:	4%	12%	11%	10%	9%
Other:	12%	8%	6%	17%	8%
PME:	3%	9%	8%	10%	8%
Tech Schools:	18%	12%	11%	0	19%
Training should not be provided:	11%	7%	4%	3%	0
Unit sponsored training:	23%	31%	26%	34%	40%

The unanimous leading contender for effective training was the unit. We agree with this choice. Each unit has specific operational needs and realities that change over time and may be addressed properly only at the unit level. Tech school is probably not the best venue for this training. Personnel graduating from tech school report to units with widely varying work demands. It would be difficult to create a fatigue training course aimed at a technical specialty (excluding aircrew).

In light of the AF/SG policy establishing the HPTT as the source of fatigue training and consulting, the HAWC would be an inappropriate choice. It would present a duplication of effort within the medical community.

Since all active duty personnel are subject to sustained and night operations at any time, we recommend a 3-tiered approach to fatigue training (including sleep hygiene and fatigue countermeasures). First, a general course on sleep, sleep hygiene, fatigue, and fatigue countermeasures should be taught during Basic and commissioning training. These subjects should then be updated during PME. Second, units engaging in shift work should provide unit- and mission-specific fatigue training, mentored by the HPTT. Finally, mission-specific fatigue ORM should be practiced by the unit (Miller, 2005).

MOST COMMON SHIFT WORKER COMPLAINTS

Shiftworkers were asked, *Of the following, select the biggest disadvantage of being a shift worker.* They responded:

Constant fatigue or sleep deprivation:	14%
Family issues (financial, childcare):	6%
Health problems:	1%
Lack of visibility (not noticed or nominated for awards):	9%
Longer work week:	21%
No disadvantages:	16%
Out of synch with family/rest of world:	32%

The most frequently-reported disadvantaged was being out of synch with one's family and the remainder of society (32%). The runner-up was a longer work week (21%). This may be a misperception. The average work week length for all 4-crew systems is, by definition, 42 hours. This is only a 5% increase over the nominal 40-h week and should not be a major

issue. It is likely that this perception was triggered by the addition to the basic shift work schedule of (1) pre- and post-shift transition time and (2) required duty on rest days.

The sleep deprivation problem is reported by many shift workers and may be tied to the higher on-duty error rates of shift workers (Folkard and Tucker, 2003).

Supv/Sched, Supt/SE, 1stSgt/CC and CMS were asked, *What are the most common complaints you receive from your workers regarding shift work? Check all that apply.* Their response distributions were:

	<u>Supv/Sched</u>	<u>Supt/SE</u>	<u>1stSgt/CC</u>	<u>CMS</u>
Family problems:	42%	44%	37%	24%
Fatigue:	40%	33%	34%	45%
Health issues:	7%	7%	4%	3%
Lack of shift rotation / stuck on one shift too long:	30%	21%	20%	7%
No opportunity for off-duty education / employment:	44%	45%	42%	10%
Other:	20%	20%	13%	31%
Required to come in on off days for various reasons:	58%	55%	54%	52%
Too many hours:	33%	30%	31%	21%
Unpredictability of schedule:	37%	27%	23%	21%

More than half of the respondents in all categories reported that the most common complaint among shift workers was having to come in on days off. This probably indicates two significant, interacting problems: one with staffing levels and one with shift work scheduling. This complaint was also probably tied to the issues of contiguity of days off and the prevention of chronic fatigue⁶.

A runner-up was complaints about off-duty employment and education. Perhaps these should have been two separate response options. Off-duty education may hold a higher precedence than a secondary job with respect to advancement in grade. However, for shift workers in grades E-1 to E-4 (37% of the respondents) who have families to support, off-duty employment may be essential.

Family problems have been reported widely in the shift work research literature.

Fatigue was reported as a source of shift worker complaints by 33% to 45% of the respondents. Schedule unpredictability is known to be one of three main worker satisfaction

⁶ Chronic fatigue is associated with being exposed frequently during at least one month to multiple periods of prolonged wakefulness, excessive work hours, disturbed or shortened major sleep periods, unresolved conflicts, or prolonged frustration. An individual must display, concurrently, four or more of the following symptoms: the desire to sleep, apathy, substantial impairment in short-term memory or concentration; muscle pain; multi-joint pain without swelling or redness; headaches of a new type, pattern or severity; unrefreshing sleep; and post-exertional malaise lasting for more than 24 hours. The symptoms must have persisted or recurred for at least one month. It is not eliminated by any number of sleep periods without first removing the cause.

issues in shift work scheduling, and is subsumed under the shift work scheduling principle of Schedule Predictability⁷.

The lack-of-shift-rotation complaint echoed the general dissatisfaction of shift workers with fixed shifts. This problem is subsumed under the shift work scheduling principle of Equity¹.

With respect to fatigue, these respondents reported that fatigue was a much more common complaint than reported by shift workers as the main disadvantage of shift work (14%). This mismatch may be due to an unwillingness or inability among shift workers to admit to their supervisors that they are fatigued. The latter situation is consistent with both a "can-do" attitude and the fatigue-induced tendency for human operators to underestimate the degree to which their cognitive performance has been impaired by fatigue. Unfortunately, this mismatch may imperil system safety and effectiveness: the superintendent needs to know when a shift worker is too tired to function safely and/or effectively so that appropriate fatigue countermeasures may be employed.

OFF-DUTY EMPLOYMENT ISSUES

Shift workers were asked, *Do you work an off-duty job?* They responded:

Yes, 1-10 hrs/week:	2.9%
Yes, 11-20 hrs/week:	2.4%
Yes, 21-40 hrs/week:	0.7%
No:	94.0%

Thus, 6% (351) of the shift workers indicated that they worked an off-duty job. (Of these, 170 were E-1, E-2, E-3, or E-4.) In a classic 4-crew shift work system, one crew must cover one-quarter of the work week, or 42 hours, on average. They must also deal with pre-and post-shift transitions, adding another several hours of primary duty work per week. They must also deal with additional duties and being called in unexpectedly to work. Thus, they may be committed to an average of 50 hours on duty per week. The amount of off-duty employment should be viewed in that light: how many hours per week should one work? Given high-quality, nocturnal sleep, it is not unreasonable for young, healthy, motivated personnel to work up to a total of 80 hours per week (the present limit for medical residents). However, safeguards against chronic fatigue should be implemented by the shiftworker who chooses to engage in off-duty employment.

Supv/Sched, Supt/SE and 1stSgt/CC were asked, *What percentage of your personnel engage in off-duty employment?* CMS were asked, *What percentage of your professional medical staff engage in off-duty employment?* Their response distributions were:

	<u>Supv/Sched</u>	<u>Supt/SE</u>	<u>1stSgt/CC</u>	<u>CMS</u>
None:	42%	23%	13%	21%
1%-10%:	38%	51%	49%	72%
11%-25%:	9%	12%	17%	3%
26%-50%:	3%	2%	3%	3%
51%-75%:	0.4%	0.5%	3%	0

⁷ Miller JC. Military Aviation Fatigue Countermeasures Workshop, Fatigue Countermeasures Branch, Air Force Research Laboratory, Brooks City-Base TX, 2004.

76%-100%:	0.4%	1%	3%	0
Don't know:	8%	10%	13%	0

Across these supervisory personnel, 58% to 87% reported that their shift workers were engaged in off-duty employment (*i.e.*, did not report “none”). Compare this to the 6% of shift workers who reported being engaged in off-duty employment (Figure 4). This is a surprisingly large mismatch that is unexplained by the present data set and that needs additional investigation.

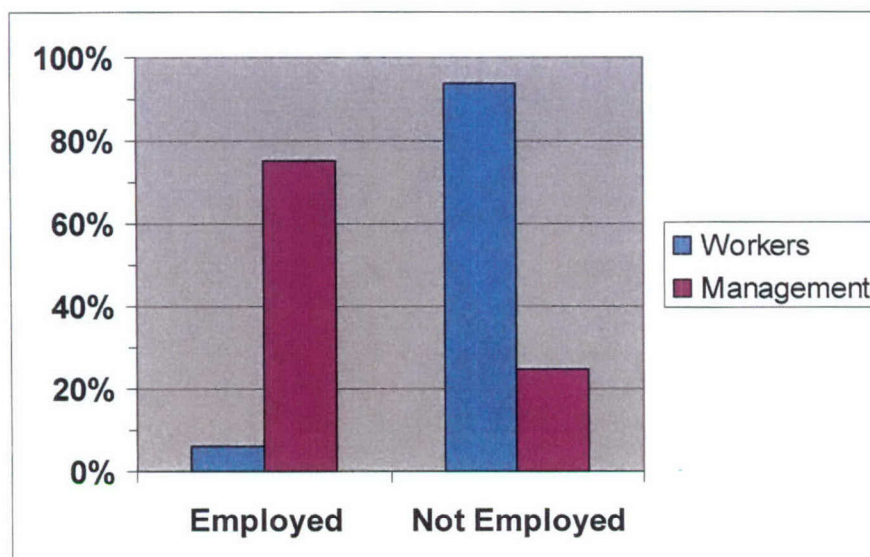


Figure 4. Comparison of reports of off-duty employment.

Shift workers were asked, *Does your off-duty employment affect your on-duty fatigue level?* Supv/Sched, Supt/SE and 1stSgt/CC were asked, *Does off-duty employment affect your shift workers' on-duty performance/fatigue levels?* CMS were asked, *Does off-duty employment affect your shift workers' / residents' / providers' on-duty performance/fatigue levels?* Their response distributions were:

	<u>Shiftworkers</u>	<u>Supv/Sched</u>	<u>Supt/SE</u>	<u>1stSgt/CC</u>	<u>CMS</u>
Yes:	1%	6%	9%	14%	0
No:	7%	46%	46%	37%	76%
Don't know:	1%	17%	22%	36%	10%
Not applicable:	91%	31%	22%	12%	14%

Perhaps some of the shift workers avoided a *Yes* answer out of concern that, had they answered otherwise, they would receive pressure to quit their off-duty job. An independent view of this issue should be acquired, such as a careful review of on-duty incident records, stratified by off-duty employment amounts. It is likely that on-duty fatigue will be induced by off-duty employment, especially when either on- or off-duty work occurs at night. Thus, all shift workers involved in off-duty employment may have been viewed by supervisors as carrying additional fatigue on duty.

SOCIAL OR BEHAVIORAL TRENDS

Shift workers, Supt/SE, 1stSgt/CC, and CMS were asked, *Are you noticing any social/behavioral trends associated with shift worker fatigue? Check all that apply.*

	<u>Shift workers</u>	<u>Supt/SE</u>	<u>1stSgt/CC</u>	<u>CMS</u>
Depression:	22%	10%	11%	14%
Domestic violence:	2%	3%	4%	0
Drug use (prescription, OTC, illegal, etc.):	3%	1%	2%	3%
Excessive drinking:	16%	12%	14%	3%
Mood swing / irritability:	50%	29%	28%	14%
Not noticing trends:	46%	67%	65%	83%
Workplace violence:	4%	2%	1%	0

Mood swings and irritability and a failure to notice trends dominated the shift workers' responses. Mood swings and irritability are well-known hallmarks of fatigue. The frequent reports by shift workers of depression and excessive drinking were disturbing. Shift work-induced depression has not been cited as a factor in the recent upswing in suicide frequency in the Air Force. Perhaps this possible relationship should be examined.

Unlike the shift workers, a failure to notice trends dominated the superintendents' responses. In general, shift workers appeared to be nearly twice as likely to report shift work-induced social and behavioral problems than superintendents. This difference supported the shift workers' contention that 57% of unit leadership did not understand or was indifferent to the impact that shift work has on the lives of their workers (below).

POLICY GUIDANCE

Shift workers, CMS and SEG were asked, *Does your functional area have any policy guidance (e.g. AFIs/OIs/policies) regarding shift work schedules, scheduling, or rest standards?* They responded:

	<u>Shift workers</u>	<u>CMS</u>	<u>SEG</u>
Yes:	27%	45%	28%
No:	16%	41%	48%
Don't know:	57%	14%	24%

About 73% of the shift workers and too few of the CMS and SEG knew of no shift work scheduling or worker rest policies in their functional area. This is a problem that must be addressed by the Air Force. Over 60 AFIs were cited by the other respondents. Nine AFIs addressed fatigue management, but 8 of these were for aircrews and air traffic control. The other one dealt with communications-electronics maintenance management. Thus, at least (52 / 60 =) 87% of the cited references were inappropriate.

SHIFT CHARACTERISTICS

Shift workers and Supt/SE were asked, *What is your current shift?* They responded:

	<u>Shift</u> <u>workers</u>	<u>Supt/SE</u>
Days:	43%	90%
Swings:	31%	7%
Mids:	26%	3%

About 26% of the shift work force was working the Mid shift at the time they took the survey. This is consistent with the standard, 4-crew solution to 24/7 operations, in which one-quarter of the shift workers at a site are working one of three shifts each day. The slightly larger proportion for Swings suggested the existence of some less-than-4-crew operations. The much larger proportion for Days suggested that many shift workers who responded were irregular Day workers. That is, they worked early in the day some weeks and late in the day other weeks. This is consistent with the work schedule for Undergraduate Pilot Training in AETC, and AETC provided 19% of the respondents (Table 1). Because the Mid shift encompasses the midnight-to-dawn period, workers on this shift are at great risk for making fatigue-induced errors on the job. Operational risk management (ORM) for fatigue should be implemented for these workers (Miller, 2005).

Unlike the shift workers, of whom about 26% were working the Mid shift at the time they took the survey, 90% of the superintendents were working the Day shift. This is not at all unusual in the shift work community.

Shift workers were also asked, *How many hours is your current shift, including pre and post shift duties (excluding "on call" time)?* They responded:

Less than 8 h:	2%
8 to 9 h:	38%
9 to 10 h:	20%
10 to 11 h:	7%
11 to 12 h:	6%
12 to 13 h:	15%
More than 13 h:	12%

There were two modes in this distribution: one at and above 8 hours and one at and above 12 hours, taking into account the effects of pre- and post-shift duties on reported shift length (Figure 5). This is a good sign: only factors of 24 hours (i.e., 4, 6, 8, 12 hours) are useful shift lengths if one wishes to build a schedule that complies with as many shift work scheduling principles as possible. The two modes suggested that most schedules are based upon these two factors of 24 hours.

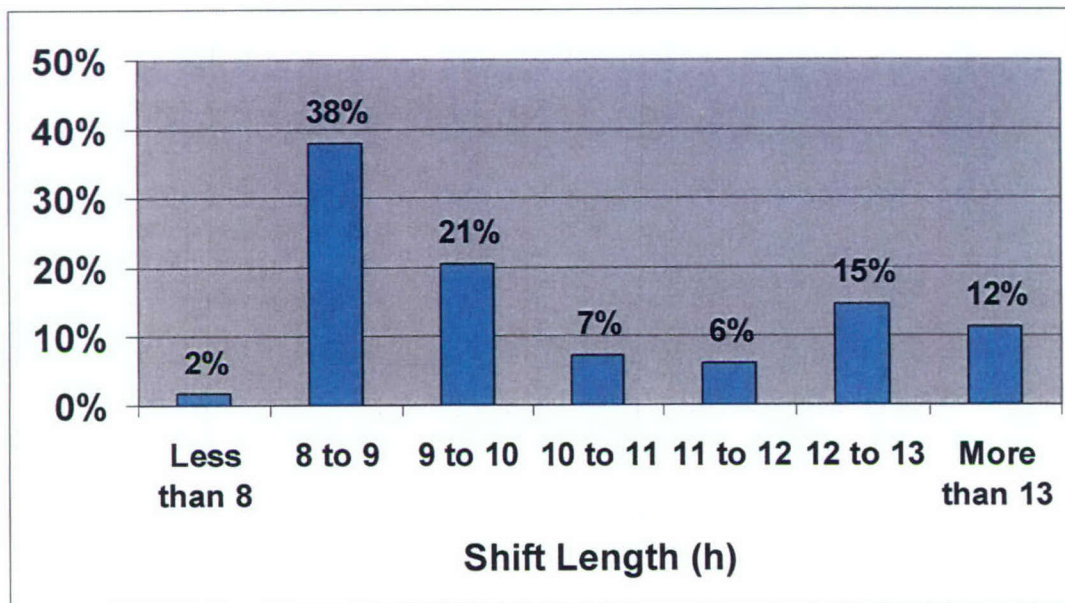


Figure 5. Distribution of shift length, including pre- and post-shift duties.

Shift workers and Supt/SE were asked, *How often do you rotate shifts?* They responded:

	<u>Shift workers</u>	<u>Supt/SE</u>
Every 2 days:	5%	3%
Every 3 days:	4%	3%
Weekly:	7%	6%
Monthly:	10%	8%
Quarterly:	25%	24%
Annually:	8%	6%
Permanent shifts (no rotation):	41%	50%

The reports revealed a bimodal distribution, with modes for quarterly rotation and permanent shifts (Figure 6). These two modes provided good and bad news, respectively. A quarterly, or slow, rotation speed is quite acceptable and is used often in the United States (rapid rotation, another acceptable approach, is used more often in Europe). Fortunately, few respondents reported a weekly rotation, which is the worst possible rotation speed with respect to shift lag issues. However, half of the respondents reported being on permanent shifts. Generally, shift workers view permanent shifts as being inequitable. Schedule equity is known to be one of three main worker satisfaction issues in shift work scheduling, and should be used as a shift work scheduling principle. The high proportion of permanent shifts reported suggested that worker satisfaction and retention may have been much lower than they could have been with good schedules.

For the Supt/SE, this question was ambiguous. It may have been perceived as referring to the individual or to the shift workers supervised by the individual. With 90% of the superintendents reporting that they were working on the day shift, it is difficult to understand why only 50% reported being on permanent shifts. The distribution of rotation speeds reported by superintendents was quite similar to that reported by shift workers, with a slightly higher frequency for permanent shifts reported by superintendents. We concluded

that the superintendents did not answer this question for themselves, but rather for their shift workers.

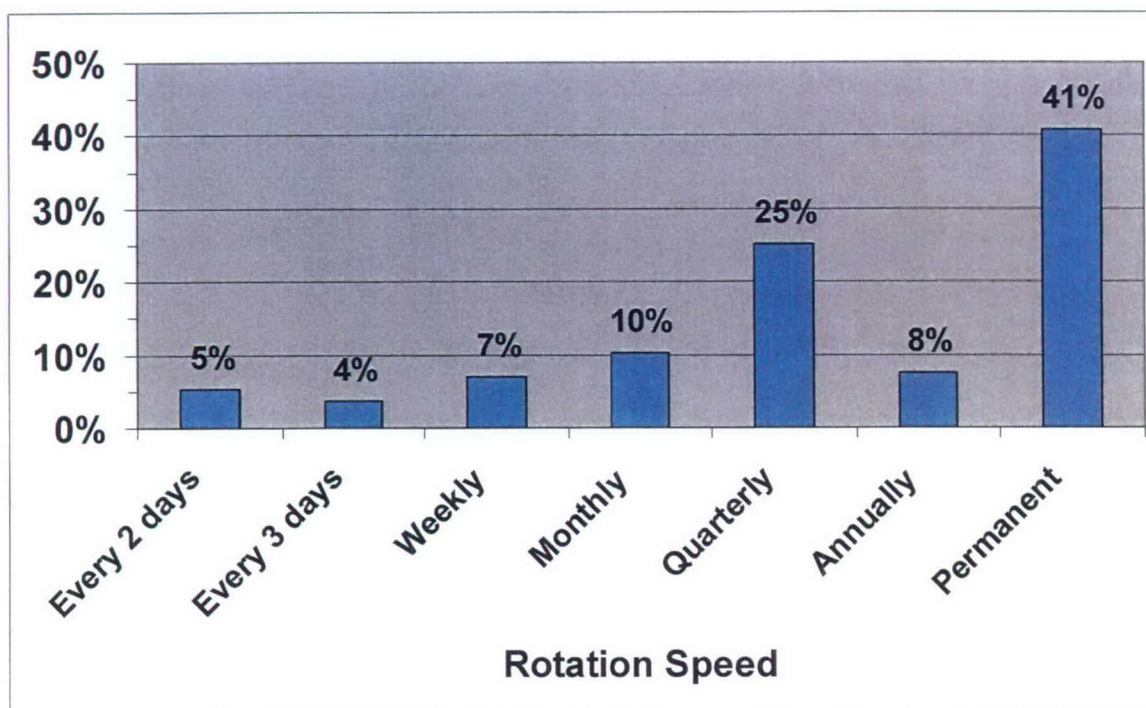


Figure 6. Distribution of shift rotation speed.

Shift workers and Supt/SE were asked, *How long has this shift rotation schedule been in effect?* They responded:

	Shift workers	Supt/SE
0-12 months:	29%	20%
13-24 months:	5%	8%
Over 24 months:	18%	37%
Don't know:	48%	35%

These data were difficult to interpret. With nearly half of the respondents selecting the "Don't know" category, one might assume either that many schedules were quite old or that many shift workers were quite new to the unit. Ignoring that half of the sample, we noted the bimodal distribution in the other half of the sample, with modes for younger schedules (0 to 12 months) and older schedules (over 24 months). Thus, we may conclude that some units had stayed with a schedule that may have been working reasonably well for their operation while other units had changed or originated schedules within the previous 12 months. However, the responses tell us nothing about the relative qualities of the schedules. Thus, we cannot discern whether good schedule designs were associated with schedule longevity. It would be of interest to learn, more specifically, the general age of shift schedules and their designs.

For the Supt/SE, we noted a bimodal distribution, with modes for younger schedules (0 to 12 months) and older schedules (over 24 months). Consistent with their supervisory positions,

the frequency of *Don't know* responses by superintendents was lower than that for shift workers.

Shift workers were asked, *How predictable/reliable is your shift schedule?* and, *How far in the future do you know your duty schedule?* They responded:

<u>Predictability</u>	
Very predictable:	40%
Somewhat predictable:	37%
Not predictable:	24%
<u>Length</u>	
Less than a week:	21%
At least a week:	33%
At least a month:	31%
At least a quarter:	8%
A year or more:	8%

Only 40% of the shift workers reported that their schedule was predictable. Worse, that predictability extended only from less than a week to a month for 80% of the shift workers. Schedule predictability is a fundamental principle in shift work schedule design, with a large impact on job satisfaction and retention. Good schedule design allows predictability into infinite time because the schedule is cyclic and equitable. The poor levels of predictability reported by these shift workers suggested that worker satisfaction and retention may have been much lower than they could have been with good schedules.

Generally, shift scheduling in the Air Force appears not to be based upon scientific fatigue-countermeasures research, but rather on equity, inertia, manning, and scheduler experience.

SLEEP CHARACTERISTICS

Shift workers and 1stSgt/CC were asked, *How much uninterrupted sleep do you typically get when off-duty?* They responded:

	<u>Shift workers</u>	<u>1stSgt/CC</u>
Less than 6 hours:	29.9%	23%
6 hours:	29.0%	40%
7 hours:	18.5%	28%
8 hours:	15.6%	9%
More than 8 hours:	7.0%	0.2%

Unfortunately, this question did not discriminate between duty days and rest days. From the distribution of responses (Figure 7), it appeared that the respondents answered primarily on the basis of rest between shifts on consecutive duty days.

The mode for 1stSgt/CC was 6 hours, while shift workers displayed a flatter distribution and a mode at fewer than 6 hours. Thus, shift worker sleep length was apparently much more variable than 1stSgt/CC sleep length.

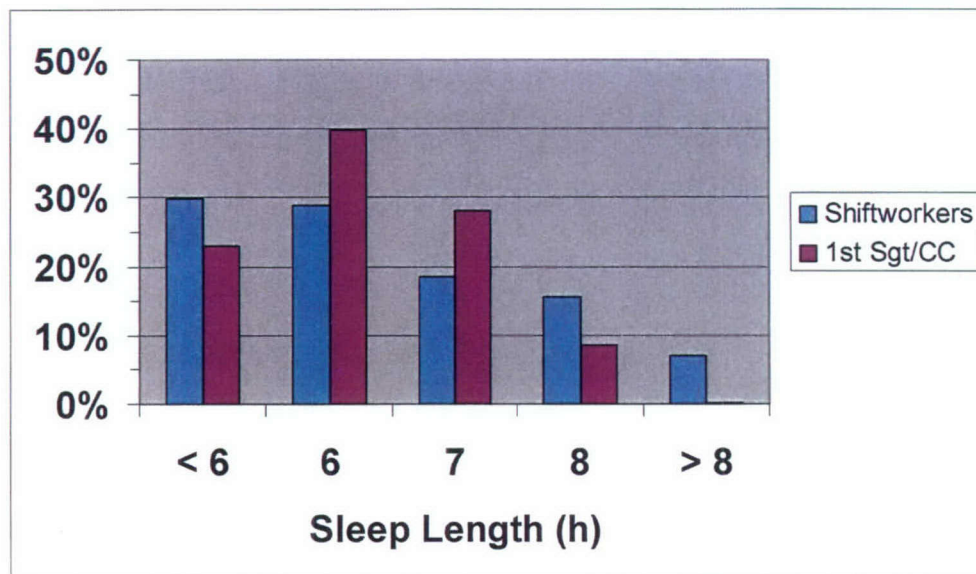


Figure 7. Distribution of shift worker and 1stSgt/CC sleep lengths.

CREW REST INTERRUPTIONS

Shift workers and 1stSgt/CC were asked, *What is your primary sleep interruption?* They responded:

	<u>Shift workers</u>	<u>1stSgt/CC</u>
Environmental (noise, lighting, temp., etc.):	35%	35%
Family:	15%	14%
Health factors (diet, stress, insomnia):	8%	14%
Pharmacological items (caffeine, alcohol, etc):	0.3%	0
Work related (called into work, appointments):	42%	37%

The leading cause of sleep disruption reported by the shift workers and 1stSgt/CC was work-related (42%). More details on these work-related interruptions are presented, below. The leading cause of sleep disruption reported by the shift workers and 1stSgt/CC was work-related (42%). More details on these work-related interruptions are presented, below. Environmental factors topped the remainder of the list for both groups. Basic sleep hygiene instruction covers this issue. Thus, it appeared that either sleep hygiene instruction was not provided or environmental factors were insurmountable. The latter case may easily occur in a forward operating area.

Shift workers were asked, *How often are you scheduled for official duties during your off-duty time?* They responded:

	<u>Shift workers</u>
Weekly:	27.6%
Not scheduled on off days:	20.3%
Monthly:	19.4%
Twice a month:	19.0%
Quarterly:	9.3%
Daily:	4.5%

About 66% of the workers reported being scheduled for duty on their rest days from once per week to once per month, and only 20% were not scheduled for work on their rest days. The shift workers were also asked, *If scheduled, please select all applicable reasons.* They responded:

	<u>Shift workers</u>
All of the above:	15.5%
Ancillary training:	27.7%
CSAF new fitness programs:	24.0%
Details:	19.8%
Not applicable:	26.4%
Official appointments:	47.6%

Official appointments topped the list of reasons for interrupting shift workers' rest days. Training sessions and fitness programs came in a distant second and third, with work details placing a close fourth behind them. While it is of interest to know what duty is of such importance that shift worker rest days must be interrupted, at the risk of causing more on-the-job, fatigue-induced errors, the main point here is that the shift work schedule and/or manning allocated for 24/7 operations is/are inadequate. They are inadequate because they do take into account the realities of day-to-day, 24/7 Air Force operations and training. Management may implement a 5-crew solution to the 24/7 scheduling problem to deal with this problem.

FATIGUE COUNTERMEASURE TECHNIQUES

Shift workers, 1stSgt/CC and CMS were asked, *What techniques do you use to combat on-duty fatigue? Check all that apply.* The response distributions were:

	<u>Shift workers</u>	<u>1stSgt/CC</u>	<u>CMS</u>
Authorized naps:	4%	5%	17%
Caffeine:	67%	68%	69%
Eat something:	51%	32%	41%
Environmental controls:	17%	23%	69%
Exercise:	28%	60%	55%
Move around / Talk to others:	73%	79%	86%
Other:	22%	5%	10%
Scheduled breaks:	27%	35%	55%
Watch TV / Listen to music:	29%	9%	1%

Interestingly, the most effective fatigue countermeasure, authorized naps, placed low and last on these lists. The effective countermeasure, caffeine, placed high on the lists, but we have little confidence that caffeine was not abused. Another effective countermeasure, scheduled breaks, placed rather low on the lists. Moving around and talking, along with exercise and environmental controls, are known to have only brief, mildly alerting effects but they placed rather high on the lists. Eating may have a transient alerting effect if blood sugar is elevated sharply, but the repeated use of this countermeasure may lead to large swings in alertness and mood. Watching television may, in fact, be soporific.

LEADER ATTITUDES

Shift workers, 1stSgt/CC and CMS were asked, *Which best describes your unit leadership's attitude towards shift work?* They responded:

	<u>Shift workers</u>	<u>1stSgt/CC</u>	<u>CMS</u>
Understands the impact of shift work on workers:	43%	84%	93%
Does not understand the impact of shift work on Workers:	20%	3%	3%
Indifferent to the impact of shift work on workers:	36%	12%	3%

The shift workers perceived that 56% of unit leadership does not understand or is indifferent to the huge impact that shift work has on the lives of their workers. On the other hand, about 85-90% of the leadership thought that they did understand the impact.

PRE-DAWN TASKS

Shift workers and Supt/SE were asked, *Are safety-sensitive/complex technical tasks scheduled from 0300-0500?* They responded:

	<u>Shift workers</u>	<u>Supt/SE</u>
Yes:	22%	42%
No:	29%	43%
Don't know:	49%	15%

It did not appear that "safety-sensitive task" was defined in the questionnaire. This may account for the large proportion of "Don't know" responses. We define safety-sensitive tasks as those that may affect personal or public safety such as command and control, operating weapons, driving, and flying as a crewmember. Unlike the shift workers, the superintendents seemed more comfortable with providing a *Yes* or *No* to this question: about 42% of superintendents reported that safety-sensitive tasks were performed in the pre-dawn hours.

SHIFT WORK-FATIGUE-INDUCED ACCIDENTS AND INCIDENTS

Shift workers were asked, *Have you had any adverse safety events due to shift-schedule induced fatigue?* We could not calculate a Yes/No count directly from this open-ended question. Thus, we relied on the following *Not applicable* number to estimate that 13% answered *Yes*. If *Yes*, then *Did you report this incident to safety personnel?*

Yes:	3%
No:	9%
Don't know:	1%
Not applicable:	87%

Incidents were apparently reported to Safety by only $(0.03 \times 0.13 =)$ 23% of the respondents who knew of incidents. The reason for such low compliance in reporting should be determined. Possibilities include: events falling below formal reporting criteria, close calls and near misses with no damage or injury to report, investigators not trained on human factors or fatigue, fear of retribution, lack of awareness of reporting requirements, and administrative burden.

The shift workers were then asked, *How serious was the incident?* They responded:

Fatality involved:	0.3%
Government property damaged:	1%
Injury:	2%
Lost duty time:	1%
Not applicable:	94%
Other:	4%

Looking back at the question, *Did you report this incident to Safety personnel/ representative?* The *Yes* responses were distributed as:

Fatality involved:	66%
Government property damaged:	62%
Injury:	27%
Lost duty time:	66%

Apparently, injuries were downplayed in terms of reporting compared to other occurrences. [We note that management was certainly aware of all fatalities and nearly all property damage and lost duty time. However, the survey respondent may not have been the primary reporter of the incident.] There are many, obvious possibilities for this disparity: it is more difficult for management to detect the occurrence of any injury, compared to the other levels of seriousness; unwillingness to do paperwork; perception that reporting the injury will not improve system safety; injuries that are very minor; etc.

ENDURANCE MANAGEMENT PROGRAM

Aerospace Physiologists and Flight Surgeons were asked, *Are you aware of the Endurance Management Program (EMP) directed by AF/SG in 2003?* They responded:

	<u>AP</u>	<u>FS</u>
Yes:	76%	28%
No:	24%	72%

Flight Surgeons were asked, *Was the HAWC actively engaged in the EMP?*

Yes:	1%
No:	14%
Don't know:	84%

SHIFT WORKER-SPECIFIC ISSUE

Of the following, select the biggest advantage of being a shift worker.

Better access to business/services:	8%
Enables off-duty education/employment:	11%
Less supervisor oversight:	10%
More continuous time off:	11%
More productivity:	9%
No advantage to being a shift worker:	30%
Other:	8%
Schedule predictability:	13%

Almost one-third of the respondents saw no advantage in shift work. While about 40% of the shift workers reported that they had a predictable schedule, only 13% reported predictability as an advantage. This is not surprising. Shift work that includes the mid-shift is aversive: humans are not designed to work at night and we experience *malaise* as a result of night work. Though predictability is desirable in a shift work schedule and is used as a scheduling principle, it serves more to reduce the aversiveness of shift work than to make shift work attractive.

The advantage of more continuous time off was almost undoubtedly reported by those with 12-h shift lengths. Mathematically, it is not possible to have long, contiguous periods of time off with 8-h shifts unless more than 4 crews are used or the rotation is very slow and fragmented. Few units (except in Space Command) use a 5-crew system. Slowly-rotating, fragmented 8-h systems are used, but are often unpredictable beyond a couple of weeks. Many shift workers prefer 12-h shift lengths over 8- shift lengths because the compressed work in 12-h shifts allows for several contiguous days off. College students often report access to daytime classes as a reason for choosing shift work. Access to off-duty employment is undoubtedly linked to the low pay status of our lower enlisted grades, as noted, above. The supervisor and productivity advantages are often reported by swing shift workers and the swing shift may have triggered this response. Productivity is generally lower on the mid-shift (Folkard and Tucker, 2003).

SHIFT SUPERVISOR- AND SCHEDULER-SPECIFIC ISSUES

What is the primary obstacle to optimizing your section's shift schedule?

Inertia (we've always done it this way):	6%
Lack of experienced personnel:	38%
Lack of manpower:	39%
Lack of manpower with security clearance:	5%
Shift worker resistance:	2%
Training requirements:	9%

The overwhelming majority (78%) indicated that scheduling was limited by the numbers of available personnel, especially experienced personnel.

Do you take sleep schedules or fatigue factors into account when developing your shift work schedules?⁸

Yes:	53%
No:	18%
Don't know:	2%
Not applicable - I don't make schedules:	27%

Of the 990 Schedulers who reported accounting for sleep, 470 (48%) also reported receiving formal training in shift work scheduling.

⁸ The response categories for this question revealed that about 27% of Supv/Sched were not schedulers.

The response categories for this question revealed a minor flaw in the design of the survey questions in Category 2: about 27% of the Shift Supervisors / Shift Schedulers were not schedulers.

What is your current scheduling tool?

Spreadsheet	73%
Manual - paper based	13%
Other software	4%
Other	10%

The overwhelming majority (86%) of respondents answered that they use a spreadsheet or paper and pencil. This response indicates the lack of availability to Supv/Sched of guiding principles for shift work schedule design, and tools that implement those principles.

Would you use a new automated tool if available? The overwhelming response (77%) was *Yes*, with the remainder answering *No*. More than three-quarters of the Supv/Sched who responded desired an automated tool to help with shift work scheduling.

AEROSPACE PHYSIOLOGIST-SPECIFIC ISSUES

Do you brief fatigue countermeasures, shift-work scheduling, or sleep hygiene practices to anyone on your base? An overwhelming proportion, 97%, answered *Yes*.

Are you familiar with FAST (Fatigue Avoidance Scheduling Tool)? 90% answered *Yes*.

The APs were asked, *On a scale of 1-10 (1-lowest, 10 highest), where would you rate your level of expertise on fatigue countermeasures, shift work scheduling, and sleep hygiene?* and *On a scale of 1-10 (1-lowest, 10-highest), where would you rate your audiences' level of expertise on fatigue countermeasures, shift work scheduling, and sleep hygiene?* The AP's own expertise distribution was bimodal, with modes at expertise levels 5 and 7 (Figure 8). The students' expertise distribution was truncated and right-skewed with a mode at expertise level 1.

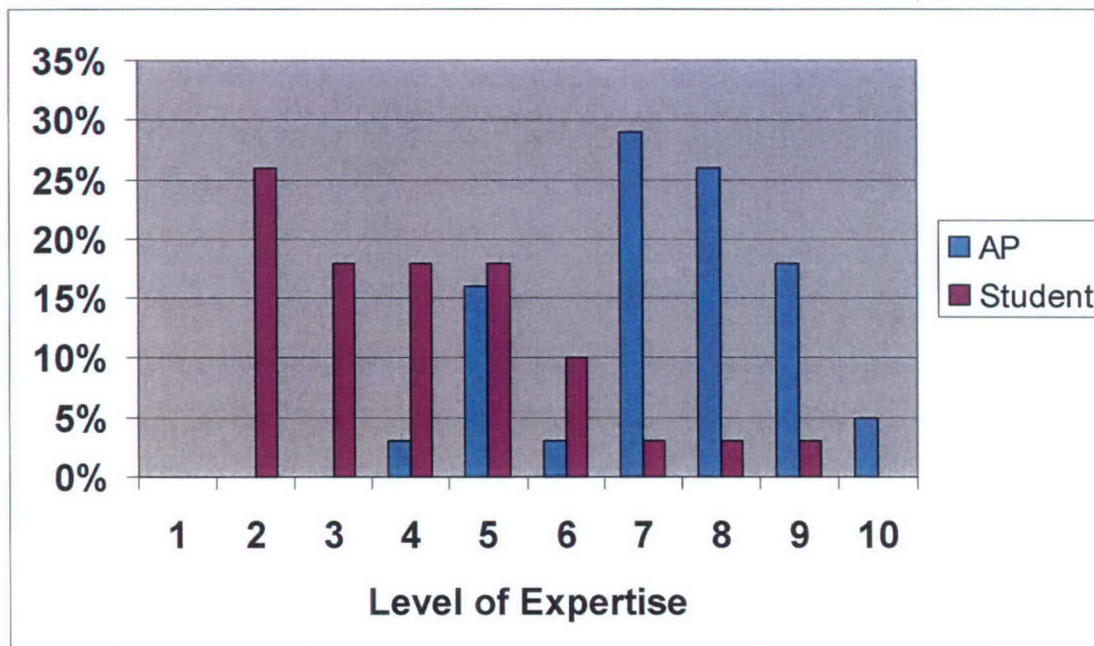


Figure 8. Expertise distributions for aerospace physiologists and their students, as estimated by the physiologists. 1 = lowest, 10 = highest expertise.

These data suggest that the 38 AP respondents were a success story with respect to fatigue management associated with shift work in the AF. They were relatively well-trained and were teaching, and they perceived their audience as being in need of the training.

CHIEF OF MEDICAL STAFF-SPECIFIC ISSUES

CMS were asked, *Do you pull on-call duty?* 66% answered *Yes*. They were also asked, *Do your providers pull on-call duty?*

Yes:	14%
No:	37%
Don't know:	36%
Not applicable	12%

Obviously, being on call is often disruptive to sleep patterns. The two main problems are truncated sleep and split sleep. In the first case, normal nocturnal sleep is interrupted and never resumed. Total sleep and rapid-eye-movement sleep times are reduced sharply and the length of continuous wakefulness during the workday is extended. Sleep length reduction and extended wakefulness are primary causal factors in fatigue induction. In the second case, normal nocturnal sleep is interrupted and then an attempt is made later in the day to acquire additional sleep. Subsequent to the second sleep period (after a period of sleep inertia) the individual will function better cognitively than if the second sleep period had not been taken, but not as well as after a full night of sleep.

What is the longest period of time a provider can go without a day off, including on-call duties?

Less than 1 week	24%
1-3 weeks	52%
1 month	0
3 months	0
Indefinitely	24%

For those in the *1-to-3 weeks* and *Indefinitely* categories, there was probably a strong likelihood of developing symptoms of chronic fatigue, as described earlier in this report.

Do your providers routinely ask patients if they are shift workers?

Yes:	14%
No:	45%
Don't know:	41%

This question should be mandatory for patients with complaints of sleep disorders or several of the symptoms associated with chronic fatigue.

WING GROUND SAFETY-SPECIFIC ISSUES

SEG were asked, *Do you include/assess fatigue as a factor when investigating on/off duty mishaps and adverse safety events?* 93% answered *Yes*. They were also asked, *Are you tracking Air Force costs associated with shift worker fatigue?* 89% answered *No*. *It was not clear why* 93% of the respondents would assess fatigue as a factor in mishaps, but only 11% kept track of the associated costs.

CONCLUSIONS AND RECOMMENDATIONS

1. The survey results represented primarily opinions:
 - From ACC, PACAF, USAFE and AETC, and not AMC
 - From workers and supervisors in grades E1 through E6
 - From shift workers, shift supervisors and shift schedulers

AMC was not adequately represented in the survey responses. Further work may be need in that command to determine patterns of shiftwork and the effects of shiftwork. Officers were adequately represented in the survey.

Training Issues

2. Fatigue management training should be made mandatory for shiftworkers and their schedulers, managers and supervisors. That training should be implemented through the Human Performance Training Team.
3. The relative weakness of superintendents' in noticing social and behavioral trends among the shift workers suggested indifference to or a lack of understanding of the impact that shift work has on the lives of their workers. Fatigue management training should be made mandatory for superintendents.

Management Issues

4. The large mismatch between supervisor and shift worker reports of frequency of off-duty employment needs additional investigation.
5. The general lack of shift work scheduling and worker rest policies for non-flyers is a problem that should be addressed.
6. Operational risk management (ORM) for fatigue should be implemented for workers on the mid shift (midnight to dawn). An AFRL technical report is available as a starting point (Miller, 2005).
7. The leading reported cause of sleep disruption was work-related. The rest days in a shift work schedule are placed there to help prevent fatigue-induced errors at work and the build-up of cumulative and chronic fatigue. These days should be treated in the same manner as the formal, inviolable crew-rest periods for aircrews. The interruption of rest days by work-related issues is a symptom of poor shift work and administrative services scheduling. The second most-frequent sleep disrupter reported was environmental factors. Basic sleep hygiene instruction may be effective in dealing with this problem. Also, investigations of AF-provided sleeping quarters may shed light on the problem.
8. The mismatch between shift workers and unit leadership about whether leadership understands the huge impact that shift work has on the lives of their workers suggested that leadership may have been out of contact with shift work reality; leadership may not have communicated well with their shift workers; shift workers may not have listened to their leadership; factors beyond the control of leadership may have prevented them from providing good schedules for their shiftworkers; etc.

Considering that there is (1) no AF reporting system that assesses the relationship between shift work-induced fatigue and ground mishaps, (2) nor data adequate to determine the relationship between shift work-induced fatigue and operational errors, (3) nor a standardized assessment protocol to determine whether fatigue is a causal or contributing factor in ground safety mishaps, (4) nor adequate policy and guidance for fatigue management in ground support career fields, it seems most likely that leadership may have been out of touch with shift work reality.

9. Without strong fatigue countermeasures, safety-sensitive tasks that are conducted during the pre-dawn generate very high risk for errors of omission and commission. The fact that superintendents schedule such tasks during this period may reflect operational realities and/or the low proportion who receive training, or adequate training, on fatigue and fatigue countermeasures.
10. Far too few fatigue-related incidents that occurred at work were reported to Safety, especially on-the-job injuries. The reason for such low compliance in reporting should be determined.

11. Management indicated that shift work scheduling options were limited by the numbers of available personnel, especially experienced personnel. Often, there is a misperception of the number of personnel needed to staff a 24/7 shift work system. Appropriate scheduling training might help with this problem. In addition, AF manpower and personnel planners should be trained to allocate the proper numbers of workers to 24/7 operations.

Scheduling Issues

12. There was some good news about shiftwork structure. Many 24/7 shiftworkers appear to be in 4-crew rotations and using 8- and 12-hours shift lengths. Too many shift workers reported shift lengths greater than 13 hours (12%). This number should be reduced sharply. Unfortunately, the frequency of shift rotation appeared to be a problem. Weekly and annual rotations and fixed shifts should be eliminated. Also, schedule predictability, which is related to retention, was weak. Shift work schedules should be based in large part on strong predictability.
13. Management should reduce sharply the need for shift workers to come in on days off. This may be accomplished by more efficient shift work scheduling⁹ and, if needed, staffing level increases. More efficient schedules should also be used to help address the fatigue and equity problems reported by the shift workers.
14. An automated shift work scheduling tool is needed¹⁰.

Sleep Hygiene and Health Issues

15. The possible relationships among reported shift worker depression, reported excessive drinking by shift workers and the recent upswing in suicide frequency in the Air Force should be examined.
16. Alarming, only 23% of the shift workers reported the acquisition of adequate sleep as defined by the sleep medicine and sleep research communities: 8 hours or more per 24-hour period. At least two countermeasures may be applied to try to increase the proportion of shift workers who get adequate sleep: sleep hygiene training by the HPTT and more efficient schedules. Also, a more detailed investigation of off-duty employment frequency among shift workers would be helpful.
17. The most effective fatigue countermeasure, authorized naps, placed low on lists of countermeasures used by shift workers. The effective countermeasure, caffeine, placed high, but we have little confidence that caffeine was not abused. Another effective countermeasure, scheduled breaks, placed rather low on the lists. Moving around and talking, along with exercise and environmental controls, are known to have only brief, mildly alerting effects but they placed rather high. The disorder in these rankings, compared to the material presented in sleep hygiene and fatigue countermeasure training

⁹ That is, principle-based schedules that deal adequately with calendar arithmetic and the zero-sum limits of the work week, month and year. At present, the first author of this report is tasked to write a draft of an AF Manual on this subject.

¹⁰ Such a tool is presently in development in this Branch of AFRL.

materials supported the conclusion that very little effective training had been provided to the respondents.

18. Flight Surgeons should learn who is tasked with teaching fatigue countermeasures. Aerospace Physiologists who do the teaching and consulting reported being well-trained and were active, and they perceived their audience as being in need of the training.
19. Management indicated that shift work scheduling options were limited by the numbers of available personnel, especially experienced personnel. Often, there is a misperception of the number of personnel needed to staff a 24/7 shift work system. Appropriate scheduling training might help with this problem. In addition, AF manpower and personnel planners should be trained to allocate the proper numbers of workers to 24/7 operations.

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21. Management should reduce sharply the need for shift workers to come in on days off. This may be accomplished by more efficient shift work scheduling¹¹ and, if needed, staffing level increases. More efficient schedules should also be used to help address the fatigue and equity problems reported by the shift workers.
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Sleep Hygiene and Health Issues

23. The possible relationships among reported shift worker depression, reported excessive drinking by shift workers and the recent upswing in suicide frequency in the Air Force should be examined.
24. Alarming, only 23% of the shift workers reported the acquisition of adequate sleep as defined by the sleep medicine and sleep research communities: 8 hours or more per 24-hour period. At least two countermeasures may be applied to try to increase the proportion of shift workers who get adequate sleep: sleep hygiene training by the HPTT and more efficient schedules. Also, a more detailed investigation of off-duty employment frequency among shift workers would be helpful.

¹¹ That is, principle-based schedules that deal adequately with calendar arithmetic and the zero-sum limits of the work week, month and year. At present, the first author of this report is tasked to write a draft of an AF Manual on this subject.

¹² Such a tool is presently in development in this Branch of AFRL.

25. The most effective fatigue countermeasure, authorized naps, placed low on lists of countermeasures used by shift workers. The effective countermeasure, caffeine, placed high, but we have little confidence that caffeine was not abused. Another effective countermeasure, scheduled breaks, placed rather low on the lists. Moving around and talking, along with exercise and environmental controls, are known to have only brief, mildly alerting effects but they placed rather high. The disorder in these rankings, compared to the material presented in sleep hygiene and fatigue countermeasure training materials supported the conclusion that very little effective training had been provided to the respondents.
26. Flight Surgeons should learn who is tasked with teaching fatigue countermeasures. Aerospace Physiologists who do the teaching and consulting reported being well-trained and were active, and they perceived their audience as being in need of the training.

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